ESRF	**Experiment title:** QUARTER WAVE PLATES AND XMCD ON BL8	**Experiment number:** HE004
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Report:

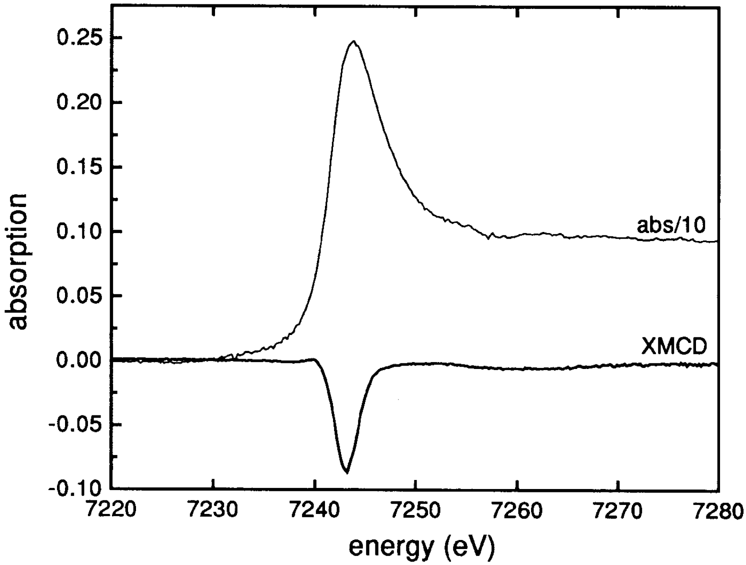
In June and August 1996 we successfully installed a diamond quarter wave plate on the energy dispersive XAS beamline at the ESRF (BL8, ID24) and we were able to carry out the first XMCD measurements at the Gd L_3 edge.

It is well-known that the linear polarisation of x-rays can be transformed into circular polarisation using a quarter wave plate (QWP). Phase plates made of birefringent materials have been used for a long time at optical wavelengths to modify the incident state of the incident radiation. For linearly polarised x-rays whose electric field is inclined at an angle ψ with respect to the diffracting plane of the phase plate crystal, the circular polarisation rate depends on the phaseshift Φ between the two components E_σ and E_π transmitted by the crystal:

$$\tau = (I_R - I_L)/(I_R + IL) = \sin 2\psi \sin\Phi.$$

If the crystal diffracting plane is inclined at 45° with respect to the incoming electric field and the phaseshift is 90°, the transmitted beam is fully circularly polarised. Close to Bragg conditions, the phaseshift between E_σ and E_π depends on the crystal thickness and on the offset $\Delta\Theta$ (i.e. the angular difference between the angle of incidence and the centre of the diffraction profile).

A 0.77-mm thick diamond crystal was installed after the Si monochromator of BL8. The non-dispersivity condition between the Si polychromator and the diamond crystal was met using a symmetric (1 11) reflection of the Si curved crystal coupled with the diamond plate set close to the **111** reflection in the asymmetric Laue geometry. Our previous tests at LURE have proved that by tuning ψ around 45° the QWP can operate in these conditions between 6 and 9keV.



The efficiency of the quarter phase plate was checked by carrying out XMCD measurements (e.g. it is known that the XMCD amplitude depends on the circular polarisation rate) at the L_3 edge of gadolinium (-7200 eV). The XMCD signal measured for a $GdCo_5$ sputtered film is presented in the figure, This was obtained at 300K by fixing the x-ray helicity (*i.e.* the offset angle of the QWP with respect to Bragg condition was 0.025°) and by alternating 331 times the direction of the applied magnetic field. The total time needed to obtain this spectrum was about 100 minutes. The edge-jump in the total cross section *is* close 0.5 and the XMCD reaches 4.5* 10-2 with a noise before the edge of 10^{-4} *i.e.* a signal/noise ratio of the order of 1000 which can be improved with longer acquisition times. XMCD spectra with a signal/noise ratio of 100 have been obtained in a few minutes. The magnetic field was issued by a permanent magnet system (developed by Magnetic Solutions, Dublin) capable of delivering a homogeneous magnetic field of 1.05 Tesla over a large (30*30 mm^2) surface. The system is mounted on a pneumatic-driven rotation stage capable of rotating by 180° in less than one second.

The amplitude of the XMCD signal (9%) *is* almost twice as that obtained at LURE on the same sample and we can roughly estimate that the maximum circular polarisation rate with the ESRF set-up should be larger than 90°/0. Datailed analysis should provide an accurate figure,

XMCD signals can also be obtained by fixing the magnetic field direction and by changing the x-ray helicity from left to right by choosing offset positions on opposite sides of the Bragg reflection conditions. The signal obtained this way contains some distortions, due to the fact that the magnetic signal is superposed to a non-magnetic background related to the non equivalent diamond absorption in the two geometries. The non-magnetic background can be eliminated by carrying out two sets of measurements, with applied field of opposite directions. The possibility to carry out XMCD measurements with a fixed magnetic field presents some important advantages. The most important is that the magnetic field becomes a degree of freedom of the experiment and measurements like site-selective hysteresis curves can be carried out by inversion of the x-ray photon helicity.